

# **Rock Sampling using the Ultrasonic/Sonic Driller/Corer (USDC) for In-situ Planetary Exploration**

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## *ABSTRACT*

Future NASA exploration missions to Mars, Europa, Titan, comets and asteroids are seeking to perform sampling, in-situ analysis and possibly the return of material to Earth for further tests. Existing drilling techniques are limited by the need for large axial forces and holding torques, high power consumption and an inability to efficiently duty cycle. Lightweight robots and rovers have difficulties accommodating these requirements. To address these key challenges to the NASA objective of planetary in-situ rock sampling and analysis, an ultrasonic/sonic driller/corer (USDC) was developed. The actuator of the USDC is an ultrasonic horn transducer that is driven by a piezoelectric stack. Unlike the typical ultrasonic drill where the drill stem is acoustically coupled to the transducer, the horn transducer in the USDC drives a free flying mass (free-mass), which bounces between the horn tip and a drill stem at sonic frequencies. The impacts of the free-mass create stress pulses that propagate to the interface of the stem tip and the rock. The rock fractures when its ultimate strain is exceeded at the rock/bit interface. This novel drilling mechanism has been shown to be more efficient and versatile than conventional ultrasonic drills under a variety of conditions. The low mass of a USDC device and the ability to operate with minimum axial load with near zero holding torque offers an important tool for sample acquisition and in-situ analysis. The details of the design, computer simulation and the test results of the USDC prototypes will be presented.

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